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Bladder Reconstruction Rates Differ Among Centers Participating in National Spina Bifida Patient Registry

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Abstract

Purpose—We performed an exploratory analysis of data from the National Spina Bifida Patient Registry (NSBPR) to assess variation in the frequency of bladder reconstruction surgeries among NSBPR centers.

Methods—We queried the 2009–2014 NSBPR to identify patients who had ever undergone bladder reconstruction surgeries. We evaluated demographic characteristics, SB type, functional level, mobility, and NSBPR center to determine whether any of these factors were associated with reconstructive surgery rates. Multivariable logistic regression was used to simultaneously adjust for the impact of these factors.

Results—We identified 5,528 patients with SB enrolled in the NSBPR. Of these, 1,129 (20.4%) underwent bladder reconstruction (703 augmentation, 382 continent catheterizable channel, 189 bladder outlet procedure). Surgery patients were more likely to be older, female, non-Hispanic white, higher lesion level, myelomeningocele diagnosis, non-ambulators (all $p<0.001$) and non-privately insured ($p=0.018$). Bladder reconstruction surgery rates varied among NSBPR centers (range 12.1–37.9%, $p<0.001$). After correcting for known confounders, NSBPR center, SB type,

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mobility, gender and age (all $p<0.001$) were significant predictors of surgical intervention. Race ($p=0.19$) and insurance status ($p=0.11$) were not associated with surgical intervention.

Conclusions—There is significant variation in rates of bladder reconstruction surgery among NSBPR centers. In addition to clinical factors such as mobility status, lesion type, and lesion level, non-clinical factors such as patient age, gender and treating center are also associated with the likelihood of an individual undergoing bladder reconstruction.

Keywords

Pediatrics; Urology; Spina Bifida; Clinical Care Variation; Neurogenic Bladder

INTRODUCTION

Spina bifida (SB) is the most common permanently disabling birth defect in the US.[1, 2] Neurogenic bladder dysfunction is the norm in SB and is a major source of morbidity.[3, 4] In order to treat or avert these concerns, many individuals with SB undergo bladder reconstruction surgeries such as bladder augmentation.

Previous research has noted significant variation in the use of bladder augmentation in children with spina bifida.[5] The reasons behind this variation are not clear. A recent study revealed that patients with private insurance were more likely to undergo augmentation (as compared to incontinent urinary diversion) than were publicly insured patients.[6]

A high degree of variation in the surgical management of SB patients is concerning because such variation suggests either 1) the lack of a clear, widely accepted standard of care for the use of these surgical procedures, or 2) that surgeons do not uniformly adhere to that standard. Further, such variation implies either overuse or underuse of those procedures, either of which may be significant problems in these complex patients. Overuse of bladder reconstruction procedures is of concern due to the significant potential morbidity and expense of surgery; underuse is problematic as well, as incontinence can have a detrimental impact on patients' quality of life.[7, 8] The objective of this study was to describe current patterns of care among NSBPR centers regarding bladder reconstruction, including the patient characteristics that are associated with likelihood of surgery. Our exploratory, secondary aim was to evaluate variation in surgical patterns, with adjustment for possible differences in case mix. We hypothesized that significant variation exists among NSBPR clinics in the use of bladder reconstruction procedures.

PATIENTS AND METHODS

Data Source

The NSBPR was established following a 2005 survey of SB centers across the US by the Spina Bifida Association and the US Centers for Disease Control and Prevention (CDC). The goals of the NSBPR are to describe the SB clinic population and documenting care patterns across centers in the U.S. in order to improve the consistency and quality of care and provide an infrastructure to support SB clinical research. In 2009, the NSBPR began accruing patients at 10 clinics; in 2011, enrollment was expanded to 19 clinics. As of December 2014, the NSBPR had enrolled 5,596 SB patients from 23 clinics.

Clinics with small enrollment (< 30 patients) were excluded, leaving a total of 5,528 patients from 19 clinics for this analysis. After institutional review board approval and obtaining informed consent/assent from parents and patients, participating clinics collected longitudinal data on individuals with SB.[9, 10] Limited data were also collected on patients who were Eligible but Not Enrolled (ENE) in the NSBPR to evaluate for possible selection bias (see below). At the initial visit, basic demographic/diagnostic information in addition to previous surgical procedures were collected from each patient. At the initial visit and each subsequent annual visit, information on insurance status, education, and employment were collected in addition to any interval procedures, treatments, and outcomes.

Statistical Analysis

Predictor variables were *a priori* selected based on biologic plausibility and/or demonstrated associations in the literature. Covariates included basic patient demographics and clinical variables captured in the NSBPR: age, gender, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic or Latino, or other/refused/unknown), insurance payer (any private vs. non-private), SB type (myelomeningocele vs. non-myelomeningocele), functional level of SB lesion (thoracic, lumbar, or sacral), mobility status (community ambulator, household ambulator, non-functional ambulator, non-ambulator, or not applicable due to age if <2 years), and treating SB center.[11]

We performed bivariate tests of association between these predictor variables and our primary outcome of interest, i.e., whether a particular patient underwent a bladder reconstruction surgery. A composite “any surgery” outcome was first examined, and then individual surgeries were examined as sensitivity analyses. The specific bladder reconstruction surgeries were bladder augmentation, creation of a continent catheterizable channel (e.g., Mitrofanoff procedure), bladder outlet procedure, or vesicostomy creation/closure. We performed multivariable logistic regression to adjust for confounding among the above covariates and outcomes. Level of lesion was insignificant in the full model and thus was excluded; all other predicters listed above were included in the final model. A two-sided alpha of 0.05 and 95% confidence intervals (CI) were used to define statistical significance. All analyses were performed using SAS 9.3 or R.

Selection Bias Analysis

Because of concerns that enrollment of patients into the NBSPR by SB centers was not random,[11] we used previously described statistical methods in an attempt to control for selection bias in our analysis.[12, 13] We first performed logistic regression among eligible and enrolled (EAE) patients to determine the association between various characteristics and the odds of having the procedures of interest performed in that population; due to small numbers of predicted events at some centers, center was not included as a covariate in this model. Using beta coefficients from this model, we estimated predicted probability of having bladder surgery for each eligible and not enrolled (ENE) patient according to the known variables. Then, we used this probability to assign a surgery status (yes/no) to each of the

498 ENE patients using a Bernoulli trial. In this trial, a surgery status is generated at random for each patient with a probability of ‘success’ (surgery = yes) that is equal to the previously estimated probability of surgery. This simulation was executed 10,000 times for ENE patients and each execution was identified with a unique seed number. Once all ENE patients had been probabilistically assigned a surgery status, the datasets from ENE and enrolled patients were combined into one dataset for the probabilistic selection bias analysis. In this combined dataset, enrollment was included in the model.

Selection bias is present if surgery status differed by enrollment in the different strata of the predictor variables. To test for this, we separated the datasets by surgery status and used logistic regression to model the likelihood of enrollment for individuals in each dataset, adjusted for other characteristics shown to be associated with surgery in our previous models. From these logistic regression models, we then calculated OR by exponentiating the beta-coefficients and calculated a Ratio of Selection Probability Ratios (RSPR) by dividing the OR obtained in the surgery dataset by the OR obtained in the non-surgical dataset for each stratum. Our final adjusted odds ratio (AOR) was then calculated by dividing observed OR by RSPR.

RESULTS

Demographics

In total, we included 5,528 patients with SB (Table 1). The median age of enrolled patients was 11.7 years (mean 13.4 years, range 0–82 years). Most patients were female (52.7%), non-Hispanic whites (64.1%) with non-private insurance (52.9%). Most patients had myelomeningocele (MMC) form of SB (79.5%), and the lesion was most commonly present at the lumbar level (53.5%). The majority of patients were community ambulators (53.6%).

Bladder Reconstruction Procedures in NSBPR Patients

Among NSBPR participants, 1,129 (20.4%) underwent a bladder reconstruction procedure of some kind. Of these, 703 (62.3%) underwent bladder augmentation, 382 (33.8%) underwent creation of a continent catheterizable channel, 189 (16.7%) bladder outlet procedure, and 299 (26.5%) underwent vesicostomy creation or closure. Some patients underwent multiple procedures.

Variation in Bladder Reconstruction Procedures

On bivariate analysis (Table 1), patients undergoing bladder reconstruction surgeries were older than non-surgical patients (median 16.7 vs. 9.9 years, $p<0.001$); more likely to be female (22.5 v. 18.1%, OR 1.3, $p<0.001$); more likely to be non-ambulatory (28.4% non-ambulators v. 15.4% community ambulators, OR 2.18, $p<0.001$); and more likely to have non-private insurance (21.7 vs. 19.0%, OR 1.17, $p=0.016$). Surgical patients were less likely to be non-Hispanic black or Latino than non-Hispanic white (OR 0.74 and 0.79, respectively, $p<0.001$); less likely to have a lumbar or sacral than thoracic lesion (OR 0.54 and 0.26, $p<0.001$); and less likely to have a non-MMC variant of SB (OR 0.32, $p<0.001$). Importantly, there was a significant range of surgical utilization among NSBPR centers (12.1–37.9%, OR 0.56–2.47, $p<0.001$). This effect remained consistent for each surgery tested (vesicostomy, catheterizable channel, outlet procedure, and bladder augment) in addition to the composite "any surgery" outcome.

On multivariable analysis (Table 2), reduced ambulatory ability (adjusted OR (AOR) 1.71 for non-ambulatory patients, $p<0.001$), female gender (AOR 1.33, $p<0.001$) and increased patient age (AOR 28.71 for 13–18 year olds compared with those younger than 2 years old, $p<0.001$) were significant predictors of bladder reconstruction surgery. Non-MMC lesion type was associated with lower odds of undergoing bladder reconstruction surgery (AOR 0.47, $p<0.001$. Race ($p=0.19$) and insurance status ($p=0.11$) were not associated with bladder reconstruction surgery. Consistent with our bivariate analysis, NSBPR center remained significantly associated with bladder reconstruction surgeries independent of the above demographic, social, and condition-related factors (AOR range 0.70–3.85, $p<0.001$). As on bivariate analysis, this remained consistent for each surgery tested.

Selection Bias

After adjusting for the likelihood of being enrolled if a patient had surgery (Table 3), most adjusted odds ratios were similar to the original odds ratios calculated solely based on enrolled patient data. The two exceptions were comparisons of non-Hispanic black vs. white patients and private vs. non-private insurance, both of which were not significant on initial analysis but became significant following correction for selection bias. However, it should be noted that the magnitude of these changes after bias correction was small (0.62 to 0.72 and 1.07 to 1.31, respectively; Table 3). This implies that these factors may be subject to statistically significant selection bias, but that the impact of this bias appears to be relatively limited.

DISCUSSION

In this national, multicenter study, we confirmed the presence of significant variation in the use of bladder reconstruction surgeries among NSBPR centers. The overall surgical rate across all centers was 20%. At some centers, however, only 12% of patients underwent bladder reconstruction procedures; at other centers, meanwhile, up to 38% of patients underwent bladder reconstruction procedures. To place this in context, our results indicate that 15 (79%) of the 19 included centers operated within +/− 2 SD of each other (Table 2); thus 4 centers (21%) were relative outliers in terms of surgical volume, even after adjusting for clinical and nonclinical variables. This effect remained similarly consistent for each specific type of bladder surgery as well as our main outcome of any bladder surgery.

This finding is consistent with previous publications. Wang and colleagues recently reported significant geographic variation in the use of bladder augmentation. Their analysis revealed a 6.5-fold variation in the use of bladder augmentation surgery among states, but also noted a slow decrease in surgical utilization across the country during the study period (1998–2011). This surgery is often performed to protect the kidneys; as expected, the rate of bladder surgery was inversely correlated, both geographically and temporally, with the rate of renal insufficiency admissions among SB patients.[14]

In addition to disease-related factors such as mobility status and lesion type and level, non-disease-related factors such as patient age, gender, race and the center at which an individual is treated are also associated with the likelihood of an individual undergoing bladder surgery. These findings are also in keeping with previously published literature. In another analysis, SB patients with private insurance were significantly more likely to undergo bladder augmentation (as compared to incontinent urinary diversion) than were publically insured patients.[6] As these studies highlight, the decisions to proceed with urinary reconstruction surgeries are complex and involve individuals' medical condition as well as other non-medical aspects of their care. Given the complexity of surgical decision-making in this population, it is perhaps unsurprising that some variation should exist among centers caring for individuals with SB. However, the degree of variation seen in these studies is intriguing, as it would seem to imply overuse or underuse of these procedures at some centers. In urology as in other areas of medicine, such variation has been noted to be problematic, even when consensus is lacking about the most appropriate choice of intervention.[15–20] Our results suggest that the hospital at which an individual is treated is more likely to influence surgical decision-making than his or her race, mobility status, or lesion level. Given the significant social and financial costs of bladder reconstruction surgeries, this level of variation may not be appropriate.

The findings of our study must be interpreted in the context of study limitations. The NSBPR continues to undergo improvements and modifications to ensure the validity of its data. Whereas clear definitions are provided for the functional outcomes that we have analyzed, these are still potentially subject to variation in their interpretation and reporting by different individuals at different clinics. This raises particular caveats when attempting to compare outcomes among different centers. Furthermore, data regarding patient renal function and anatomy are being incorporated into the newer versions of NSBPR which may make it possible to determine if the presence of renal impairment influences rates of bladder reconstruction surgery. Selection bias may be a threat to external validity. NSBPR is clinic-based, so it may not represent SB patients who do not attend SB clinics. It is also possible that the clinics participating in the registry are not representative of SB clinics in general; this possibility may have been amplified by our decision to exclude low-volume clinics from the analysis. No attempt was made to ensure representativeness in choosing NSBPR centers; indeed, the fact that all NSBPR clinics are hospital-based and multidisciplinary may limit its generalizability. Nevertheless, we believe that NSBPR probably characterizes the type of care received by patients at the majority of SB clinics in the United States. In addition, selection bias may be a threat to internal validity: participating clinics enrolled most, but not all, eligible patients, raising concerns that those who are eligible but not contributing data may be different from those who are. In an attempt to evaluate the possible impact of this bias, we conducted a rigorous analysis (including a 10,000 run simulation of enrolled and ENE data) based on the best available literature on this topic.[12, 13] Importantly, we did not see a marked difference in outcomes before and after these adjustments (Table 3), implying that, while it may be present, selection bias is unlikely to play a clinically significant role in our findings.

It should also be noted that institutional variability may simply represent regional differences in philosophies regarding the role of surgery for individuals with SB rather than underlying biological differences; for example, the underlying reason for performing surgery in some regions may be continence (i.e., driven by social or quality of life concerns) as opposed to bladder hostility and concern for renal compromise in others (e.g., elevated detrusor leak point pressures, etc). The goal of this report is not to pass judgment on a particular site or philosophy, but rather to highlight that the probability of bladder reconstruction surgery in a child with SB is likely to vary between institutions, and that the probability of surgery varies depending on both clinical and non-clinical factors.

CONCLUSIONS

There is significant variation in bladder reconstruction surgery rates among NSBPR centers. In addition to disease-related factors such as mobility status, lesion type and level, non-disease-related factors such as patient age, gender and treating center are also associated with the likelihood of an individual undergoing bladder reconstruction.

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KEY TO ABBREVIATIONS

SB	spina bifida
NSBPR	National Spina Bifida Patient Registry
CDC	United States Centers of Disease Control and Prevention
UTI	urinary tract infection
VUR	vesicoureteral reflux
ENE	eligible but not enrolled
RSPR	Ratio of Selection Probability Ratios
OR	odds ratio
AOR	adjusted odds ratio
MMC	myelomeningocele

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Table 1

Characteristics of Patients Undergoing any GU Reconstruction Surgery, National Spina Bifida Patient Registry (NSBPR), 2009–2014

		N (%) by GU Reconstruction Surgery			
Variables	**Overall n (%)(N=5528)**	**Yes (n=1129)**	**No (n=4399)**	**Odds Ratio (95% CI)**	**P-value**
Age group at last visit (yrs)					
Younger than 2	474 (8.6)	11 (2.3)	463 (97.7)	Reference	<0.001*
2 to <5	716 (13.0)	24 (3.4)	692 (96.6)	1.46 (0.71 – 3.01)	
5 to <10	1219 (22.1)	159 (13.0)	1060 (87.0)	6.31 (3.39 – 11.74)	
10 to <13	627 (11.3)	135 (21.5)	492 (78.5)	11.55 (6.17 – 21.63)	
13 to <18	1034 (18.7)	344 (33.3)	690 (66.7)	20.98 (11.38 – 38.69)	
18 to <22	656 (11.9)	209 (31.9)	447 (68.1)	19.68 (10.59 – 36.59)	
22 or older	802 (14.5)	247 (30.8)	555 (69.2)	18.73 (10.11 – 34.70)	
Gender					
Male	2616 (47.3)	474 (18.1)	2142 (81.9)	Reference	<0.001*
Female	2912 (52.7)	655 (22.5)	2257 (77.5)	1.31 (1.15 – 1.50)	
Race/Ethnicity					
Non-Hispanic White	3542 (64.1)	791 (22.3)	2751 (77.7)	Reference	<0.001*
Non-Hispanic Black	400 (7.2)	70 (17.5)	330 (82.5)	0.74 (0.56 – 0.97)	
Hispanic or Latino	1167 (21.1)	216 (18.5)	951 (81.5)	0.79 (0.67 – 0.93)	
Other/Refused/Unknown	419 (7.6)	52 (12.4)	367 (87.6)	0.49 (0.36 – 0.67)	
Spina Bifida type					
Myelomeningocele	4393 (79.5)	1028 (23.4)	3365 (76.6)	Reference	<0.001*
Non-Myelomeningocele	1135 (20.5)	101 (8.9)	1034 (91.1)	0.32 (0.26 – 0.40)	
Function level of lesion					
Thoracic	864 (15.6)	291 (33.7)	573 (66.3)	Reference	<0.001*
Lumbar	2957 (53.5)	641 (21.7)	2316 (78.3)	0.54 (0.46 – 0.64)	
Sacral	1707 (30.9)	197 (11.5)	1510 (88.5)	0.26 (0.21 – 0.32)	
Health Insurance					
Any private	2604 (47.1)	496 (19.0)	2108 (81.0)	Reference	0.0176*
Non-private	2923 (52.9)	633 (21.7)	2290 (78.3)	1.17 (1.03 – 1.34)	
Mobility status					

		N (%) by GU Reconstruction Surgery			
Variables	**Overall n (%)(N=5528)**	**Yes (n=1129)**	**No (n=4399)**	**Odds Ratio (95% CI)**	**P-value**
Community Ambulators	2960 (53.6)	456 (15.4)	2504 (84.6)	Reference	
Household Ambulators	395 (7.1)	88 (22.3)	307 (77.7)	1.57 (1.22 – 2.04)	<0.001*
Non-Functional Ambulators	393 (7.1)	101 (25.7)	292 (74.3)	1.90 (1.48 – 2.43)	
Non-Ambulators	1696 (30.7)	482 (28.4)	1214 (71.6)	2.18 (1.89 – 2.52)	
Center					
1	550 (9.9)	109 (19.8)	441 (80.2)	Reference	
2	93 (1.7)	25 (26.9)	68 (73.1)	1.49 (0.90 – 2.46)	
3	87 (1.6)	14 (16.1)	73 (83.9)	0.78 (0.42 – 1.43)	
4	224 (4.1)	52 (23.2)	172 (76.8)	1.22 (0.84 – 1.78)	
5	350 (6.3)	63 (18.0)	287 (82.0)	0.89 (0.63 – 1.25)	
6	314 (5.7)	47 (15.0)	267 (85.0)	0.71 (0.49 – 1.04)	
7	341 (6.2)	93 (27.3)	248 (72.7)	1.52 (1.10 – 2.08)	
8	330 (6.0)	125 (37.9)	205 (62.1)	2.47 (1.82 – 3.35)	<0.001*
9	280 (5.1)	36 (12.9)	244 (87.1)	0.60 (0.40 – 0.90)	
10	384 (6.9)	57 (14.8)	327 (85.2)	0.71 (0.50 – 1.00)	
11	315 (5.7)	73 (23.2)	242 (76.8)	1.22 (0.87 – 1.71)	
12	457 (8.3)	65 (14.2)	392 (85.8)	0.67 (0.48 – 0.94)	
13	414 (7.5)	78 (18.8)	336 (81.2)	0.94 (0.68 – 1.30)	
14	396 (7.2)	60 (15.2)	336 (84.8)	0.72 (0.51 – 1.02)	
15	182 (3.3)	22 (12.1)	160 (87.9)	0.56 (0.34 – 0.91)	
16	344 (6.2)	111 (32.3)	233 (67.7)	1.93 (1.42 – 2.62)	
17	92 (1.7)	14 (15.2)	78 (84.8)	0.73 (0.40 – 1.33)	
18	298 (5.4)	68 (22.8)	230 (77.2)	1.20 (0.85 – 1.68)	
19	77 (1.4)	17 (22.1)	60 (77.9)	1.15 (0.64 – 2.04)	

Table 2

Results from Multivariable Logistic Regression Analysis Predicting Odds of Any Bladder Reconstruction Surgery, National Spina Bifida Patient Registry (NSBPR), 2009–2014

Variables	Adjusted Odds Ratio* (95% CI)	P-value
Age group at annual visit		
Younger than 2	Reference	
2 to <5	1.97 (0.90 – 4.34)	
5 to <10	8.94 (4.47 – 17.90)	<0.001
10 to <13	17.16 (8.51 – 34.58)	
13 to <18	28.71 (14.48 – 56.91)	
18 to <22	27.56 (13.79 – 55.08)	
22 or older	23.62 (11.80 – 47.30)	
Sex		
Male	Reference	<0.001
Female	1.33 (1.15 – 1.54)	
Race/Ethnicity		
Non-Hispanic White	Reference	
Non-Hispanic Black	0.76 (0.56 – 1.03)	0.19
Hispanic or Latino	0.99 (0.79 – 1.25)	
Other	0.76 (0.55 – 1.07)	
Insurance		
Any private	Reference	0.11
Non-private	1.13 (0.97 – 1.32)	
Spina bifida type		
Myelomeningocele	Reference	<0.001
Non-Myelomeningocele	0.47 (0.37 – 0.60)	
Mobility status		
Community Ambulators	Reference	
Household Ambulators	1.30 (0.98 – 1.72)	<0.001
Non-Functional Ambulators	1.69 (1.29 – 2.22)	
Non-Ambulators	1.71 (1.44 – 2.02)	
Center		
1	Reference	
2	1.44 (0.82 – 2.50)	
3	0.74 (0.39 – 1.41)	
4	1.32 (0.88 – 1.97)	
5	0.90 (0.62 – 1.31)	
6	0.90 (0.60 – 1.35)	
7	1.96 (1.38 – 2.79)	
8	3.85 (2.72 – 5.45)	
9	1.10 (0.71 – 1.72)	<0.001
10	0.70 (0.46 – 1.06)	

Variables	Adjusted Odds Ratio* (95% CI)	P-value
11	1.13 (0.79 – 1.61)	
12	0.99 (0.69 – 1.43)	
13	0.76 (0.54 – 1.07)	
14	0.93 (0.64 – 1.35)	
15	0.56 (0.34 – 0.95)	
16	1.79 (1.28 – 2.50)	
17	0.88 (0.45 – 1.71)	
18	1.42 (0.98 – 2.06)	
19	1.32 (0.69 – 2.53)	

*All listed variables included in the final model

Table 3

Summary of selection bias analysis for bladder reconstruction surgery, National Spina Bifida Patient Registry (NSBPR), 2014

Variables	SPR, median (2.5, 97.5 percentiles) ^		Estimate of bias, median RSPR*	Observed OR (95% CI) **	OR adjusted for selection bias (95% CI) ††
	Surgery	No surgery			
	Odds of enrollment compared with referent group		Likelihood of being enrolled if the patient had surgery	Odds of having surgery compared with the reference group	Adjusted odds of having surgery compared with the reference group
Age (years)					
< 10†	Referent	Referent		Referent	Referent
10 to <18	1.57 (0.87, 2.65)	1.48 (1.33, 1.68)	1.05	4.31 (3.36, 5.52)	4.09 (3.19, 5.24)
18 or older	0.81 (0.45, 1.32)	0.83 (0.74, 0.95)	0.97	3.94 (2.98, 5.21)	4.07 (3.08, 5.37)
Sex					
Male†	Referent	Referent		Referent	Referent
Female	1.18 (0.81, 1.69)	1.07 (0.99, 1.16)	1.10	1.22 (1.00, 1.50)	1.11 (0.90, 1.36)
Race/Ethnicity					
Non-Hispanic White†	Referent	Referent		Referent	Referent
Non-Hispanic Black	0.82 (0.45, 1.87)	0.67 (0.60, 0.77)	1.22	0.79 (0.53, 1.18)	0.65 (0.43, 0.97)
Hispanic or Latino	0.95 (0.59, 1.72)	1.10 (1.00, 1.21)	0.86	0.62 (0.47, 0.83)	0.72 (0.54, 0.97)
Other	0.95 (0.50, 2.90)	1.68 (1.45, 2.04)	0.57	0.83 (0.55, 1.25)	1.46 (0.97, 2.20)
Diagnosis					
Myelomeningocele†	Referent	Referent		Referent	Referent
Other diagnosis	0.55 (0.29, 1.34)	0.55 (0.51, 0.60)	0.99	0.40 (0.28, 0.58)	0.40 (0.28, 0.58)
Level of lesion					
Thoracic†	Referent	Referent		Referent	Referent
Lumbar	1.12 (0.74, 1.68)	1.20 (1.01, 1.38)	0.94	0.82 (0.63, 1.07)	0.87 (0.67, 1.14)
Sacral	1.41 (0.77, 2.95)	1.15 (0.97, 1.34)	1.23	0.55 (0.39, 0.78)	0.45 (0.32, 0.63)
Insurance					
Private†	Referent	Referent		Referent	Referent
Non-private	0.38 (0.24, 0.58)	0.47 (0.43, 0.51)	0.82	1.07 (0.87, 1.33)	1.31 (1.05, 1.62)

* Ratio of selection probability ratio

^ Simulation of assigning surgery status for ENE was executed 10,000 times

** Odds ratio estimates from multiple logistic regression model among eligible and enrolled

† Reference group

†† Observed odds ratio and confidence interval divided by the RSPR